Co-Chairs:
Rep. Dell Raybould
Senator Laird Noh

Natural Resources Interim Committee
Legislative Services Office
State Capitol
P.O. Box 83720
Boise, Idaho 83720-0054
Fax: (208) 334-2125
E-mail: water@lso.state.id.us

NATURAL RESOURCES INTERIM COMMITTEE
EASTERN SNAKE PLAIN AQUIFER WORKING GROUP

The Eastern Snake Plain Aquifer Working Group
Is Comprised of (List Senators and Representatives)
The Working Group will, in consultation with stakeholders, develop a framework for management of the Eastern Snake Plain Aquifer to Ensure the Long-Term Sustainability of the Surface and Ground Water Supply for all Beneficial Uses in Accordance with the Prior Appropriation Doctrine as Established by Idaho Law.

INTRODUCTION

On March 15, 2004, the State of Idaho and certain water users within Water District 130 reached a verbal agreement that was subsequently memorialized as "The Eastern Snake Plain Aquifer Mitigation, Recovery and Restoration Agreement for 2004". This one-year agreement provided that the spring water users would stay pending delivery calls against ground water users diverting from the Eastern Snake Plain Aquifer ("ESPA") in exchange for implementation of a suite of short-term mitigation measures and a commitment by the Legislature to provide a forum for developing a long-term solution to address the surface and ground water supply problems associated with the ESPA. The Natural Resources Interim Committee is charged with providing the forum for the discussion of the ESPA water supply problems and intends to use the Eastern Snake Plain Aquifer Working Group ("ESPA Working Group") to help in formulating both short-term and long-term management goals and objectives for the ESPA.

THE RESPONSIBILITIES OF THE EASTERN SNAKE PLAIN AQUIFER WORKING GROUP

In accordance with "The Eastern Snake Plain Aquifer Mitigation, Recovery and Restoration Agreement for 2004," the ESPA Working Group will make recommendations to the Natural Resources Interim Committee on the following matters:

1) Recommend short-term and long-term management goals and objectives for the ESPA together with standards to determine whether the goals and objectives are being met;

2) Investigate and make recommendations regarding water supply measures or projects that should be implemented to achieve the short-term and long-term goals and objectives, including, but not limited to, a proposed ESPA recharge action plan and proposed storage projects;

3) Investigate the extent of ground water depletions from the ESPA and make recommendations for reducing or curtailing ground water depletions;

4) Investigate and make recommendations for augmenting spring flows through infrastructure projects, exchanges and other mechanisms;

5) Study and recommend methods for funding implementation of ESPA management goals and objectives;

6) Evaluate and make recommendations regarding an administrative structure for ensuring that short-term and long-term goals and objectives are implemented; and

7) Develop performance benchmarks for implementation of The Eastern Snake Plain Aquifer Mitigation, Recovery and Restoration Agreement for 2004.

OVERVIEW OF ESPA HYDROLOGIC CONDITIONS AND WATER SUPPLY ISSUES

1) Location: The eastern plain lies entirely within the Snake River Basin above King Kill and is drained by the Snake River and its tributaries. The eastern Snake River Plain is about 170 mi long, 60 mi wide, and covers 10,800 mi^2. The plain extends from Mud Lake in the northeast to King Hill in the southwest.

2) Geology: The eastern Snake River Plain aquifer is composed mostly of basalt which is over 3,000 ft thick in the center of the plain and only a few hundred feet along the margins. The basalt is very permeable and characterized by rubble and clinker zones at flow interfaces and large fractures. The basalt is intebedded with sediments deposited by the Snake River and tributary streams. There are large areas of fine-grained lacustrine sediments deposited in lakes formed by streams blocked by lava flows. There is minimal wind blown soil cover for most of plain. Most agricultural soils are the sediments along the Snake River at the margins of plain.

3) Hydrology:

   a. Surface Water

      i. The eastern Snake River plain is drained by the Snake River and its tributaries. The source of the Snake River water is snowmelt from the winter snow pack in the surrounding mountains. Most the runoff occurs in the early spring before the irrigation season begins so the water must be stored until it is needed later in the summer. The Snake River above King Hill has an extensive reservoir system with a storage capacity of about 5.5 million acre-ft.

ii. The average annual flow of the Snake River at King Hill is about 8 million acre feet; however, the Snake River flow below Milner Dam is limited to about 200 c.f.s. during much of the year because of irrigation diversions upstream.

iii. From Milner Dam to King Hill, the Snake River is entrenched in a steep basalt canyon as much as 700 feet deep. Spring flow from the north side of the canyon along with a few streams from the south rebuild the flow in the Snake River below Milner Dam. There are several large springs along the canyon such as Blue Lakes and Box Canyon springs with average flow rates of 200 cubic feet per second and 400 cubic feet per second.

iv. As a result of the incidental recharge from surface water irrigation over the ESPA, about 70 percent of the flow at King Hill is now ground water discharge from the Thousand Springs. Records indicate spring flow in the Milner Dam to King Hill reach of the Snake River increased from 4,200 cfs in 1900 to 6,800 cfs in 1950.

v. Spring flows have recently declined to less than 6,000 cfs or about 4,800,000 acre-feet per year. The cause for this decline is a combination of the reduction in incidental recharge from surface water as a result of the conversion from flood to sprinkler irrigation, extended drought and ground water pumping.

vi. The conversion from flood to sprinkler irrigation along with other factors has resulted in a reduction in surface water diversions in the upper Snake River Basin by about 900,000 acre-feet per year. This reduction in diversions has accrued to the benefit of storage space holders.

vii. An additional factor affecting the water supply in the Snake River Basin has been the pressure on the Bureau of Reclamation to provide up to 427,000 acre-feet of flow augmentation water to satisfy the Endangered Species Act.

b. Irrigation

i. Irrigation is the largest source of recharge. About 2,270,000 acres of land were irrigated in 1979. Of this, about 930,000 acres were irrigated from ground water.

ii. About 9 million acre-feet is diverted annually for irrigation. About 2 million acre-feet is returned directly to the Snake River. Another 2.2 million acre-feet is used by crops and the remaining 4.8 million acre feet is aquifer recharge.

c. Ground Water

i. Flow Rate

1. Ground water flow is a function of the rock that makes up the aquifer.

2. The flow rate is a function of hydraulic conductivity, aquifer thickness, storage capacity, and hydraulic gradient.

3. The ability of the rock to transmit water is indicated by the hydraulic conductivity. The larger the value the more easily the water flows through the rock. In the ESRP, hydraulic conductivity ranges from 0.00003 ft/sec for sediments to 0.3 ft/sec for basalt.

4. Transmissivity is the aquifer thickness times the hydraulic conductivity. A thick aquifer can transmit more water than a thinner aquifer, other things being the same. The greater the transmissivity, the greater the capacity of the aquifer to transmit water. The thickness of the ESRP varies from over 3,000 ft near the center to less than 200 ft near the margins. The thickness of the active portion of the aquifer may be much less.

5. The hydraulic gradient is the slope of the water table. The steeper the slope the larger the flow rate. The elevation of the water table drops from about 4,800 ft near Mud Lake to 3,200 ft near King Hill: about 1,600 feet in 170 miles or an average gradient of 9.4 ft/mile.

6. The ability of rock to store water is indicated by the storage coefficient which is the fraction of the rock volume that can actively store water. The average storage coefficient for the ESRP is about 5 per cent. The area of the ESRP is about 6.9 million acres (10,800 mi^2) so that one foot of aquifer thickness can store about 350,000 acre-ft of water.

ii. Regional Flow: Ground water in the ESRP occurs primarily in various overlapping basalt flows. The general ground water flow direction is from Mud Lake in the northeast to King Hill in the southwest along the major axis of the plain.

iii. Recharge

1. Recharge is primarily from surface water irrigation.

2. Recharge from other sources includes:

a. Precipitation

b. Tributary valley underflow

c. Snake River losses

iv. Discharge: Discharge is primarily from:

1. Spring flow to the Snake River

2. Consumptive use from ground water irrigation

d. Water Budget

i. On average, from 1980 to 2000, ground water recharge is nearly equal to ground water discharge. However, in recent years discharge apparently exceeds recharge and ground water levels are declining. Spring discharge is also declining as it adjusts to a new balance between recharge and discharge.

ii. Recharge for 1980

1. Surface water irrigation 4,840,000 acre-feet

2. Tributary value underflow 1,440,000

3. Direct precipitation 700,000

4. Snake River losses 690,000

5. Other stream and canal losses 390,000

iii. Discharge for 1980

1. Snake River gains 7,080,000 acre-feet

2. Net ground water pumpage 1,140,000 acre-feet

e. Ground Water Flow Modeling

i. Calibration:

1. Because of the inability to see exactly how water moves through an aquifer, scientists have developed models to predicate water flow through an aquifer based upon certain values, such as transmissivity and the storage coefficient. These values need to be provided for every part of the aquifer being modeled.

2. Ideally, a model would be based solely upon measured values; however, because of the variability of aquifers and their size, this is generally not possible. So hydrologists must estimate certain values based on a few measurements and other knowledge about the aquifer. Using these estimates the model must be capable of reproducing the observed spring discharges and ground water level changes. This is often called the inverse problem when one is trying to calculate these values directly from observations; however, the term calibration is a better description of what is often a trial and error procedure that is very dependant on the knowledge and experience of the modeler. The model is run and the resulting spring flow and water levels are compared with observed values. The values are adjusted until the residuals or the difference between the simulated and observed values is as small as possible. Modern computers and software allow a more automated approach to this procedure. PEST is a computer parameter estimation tool that is capable of evaluating many thousands of parameter combinations compared to only a few that could be performed by hand as was done with the old ESPA model.

3. Because of the size and complexity of ground water models and lack of measured values, the computer modeling approach has its limitations. A model is most useful in evaluating the change in conditions (delta) between modeled scenarios. The model, however, should not be used to determine absolute values because there is no way to make up for the many assumptions and simplifications made in the model development.

ii. History of ESPA modeling

1. Computer ground water model development began in 1970 with a model of the Rigby Fan written by Desonneville for his Masters Thesis at the University of Idaho. By 1978 the model had been extended to include most of the eastern plain above King Hill. Earlier, the U.S. Bureau of Reclamation had developed an analytical model of the area but it was abandoned when the digital computer became more available. In 1988, the USGS completed their own model of eastern plain using the USGS MODFLOW computer code as part of their Regional Aquifer Systems Analysis program.

2. A disadvantage of the University of Idaho computer code was that it did not enjoy wide use within the ground water modeling community. A technical review of the IDWR model indicated that the model lacked proper documentation and that the MODFLOW code would be more appropriate considering the intended use of the model. The UGSG MODFLOW code had become the accepted modeling tool.

So in 1999, IDWR contracted with IWRRI to convert the model from the University of Idaho code developed by Desonneville to the USGS MODFLOW code and extend the model to include the Henrys Fork area. This was the first step in a program to develop an enhanced model using the most current computer and software available and to provide documentation of the results. For convenience, the 1999 model will be referred to as the old model and the enhanced model due to be completed in 2004 will be referred to as the new model.

a. USBR Analytical model

b. 1970 Rigby Fan (IDWR model , Desonneville, U of I)

c. 1978 Extended to King Hill (IDWR model, Newton, U of I)

d. 1988 USGS RASA Program (MODFLOW, Garabedian, USGS)

e. 1999 Extended to include Henrys Fork (MODFLOW, IWRRI)

f. 2004 Enhanced (MODFLOW, IWRRI)

iii. Old model vs. new model

1. The recharge components in the new model have been updated using recent information on irrigation practices, irrigated area, precipitation, ET, and other factors. Tributary underflow was reevaluated to examine ways to provide more accurate values and a seasonal distribution that was lacking in the old model.

2. The old model used a 5-killometer grid size. The new model uses a 1-mile grid size so that it better represents important physical features such as the Snake River and provides better resolution of recharge and discharge components.

3. The new model has a finer breakdown of river reaches so that individual spring discharge is better simulated.

4. The calculation of recharge for the new model makes better use of new GIS tools and includes a scenario generation tool that simplifies the construction of input to the model.

5. The new model is calibrated using PEST. The new tool provides a better calibration and also a better measure of uncertainty about the

model results to help guide management in the application of the model.

BIBLIOGRAPHY OF RELEVANT PUBLICATIONS

1. IDWR, Resource Inventory Upper Snake River Basin, December 1998.

2. IDWR, Feasibility of Large-Scale Managed Recharge of the Eastern Snake Plain Aquifer System, December 1999.

3. U.S. Bureau of Reclamation, A Description of Bureau of Reclamation System Operations Above Milner Dam, December 1997.

4. U.S. Geological Survey, Water Use on the Snake River Plain, Idaho and Eastern Oregon, 1998.

5. Others include numerous technical studies of the aquifer by IDWR, the U.S. Geological Survey, and others.